Urban Change

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As part of our research into urban change, we are addressing two significant urban-system issues, settlement patterns and transportation infrastructure growth. Long-term, the structure of urban systems is mainly determined by a co-evolution of the settlements and the transportation system. Our urban-settlement simulation is defined as a modified Markov random field, and our road-growing simulation is defined as a recursive algorithm that locates maximum travel demand areas and grows transportation links between such areas. Both simulations take two different kinds of input: (1) current settlements, topographic, and infrastructure data and (2) demographic and economic constraints to map the dynamics of many observed phenomena, including urban sprawl and beltway formation.

Addressing a major natural disaster such as an earthquake or a wildfire in an urban setting involves accessing far-flung resources, exchanging information, and iterative consensus building, for which an interactive Web environment could be most effective. To deal with such complex problems in urban settings we are developing an Internet-based decision support system that enhances the collective intelligence in large stakeholder groups. Two examples are the “people finder databases” constructed and used during the Los Alamos Cerro Grande Fire in May 2000, and the stakeholder feedback and consensus building and conflict clarification system that is being used for the mitigation process following this wildfire disaster. In general, such a web environment provides links to a wealth of information, both predetermined and current. Real-time disaster planning sessions can take place while stakeholders remained at their home bases. The participating organizations can sort information according to issues of importance, and at the end of a fixed time period, the input can be summarized and evaluated, all in a web environment. Potential conflicts for resources would become evident and consensus would be clear. This tool could facilitate understanding between organizations, which could result in better disaster preparedness.

Urban Earthquake Modeling and Effects

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Our objective is to produce a set of real-time feedback tools to cope during a crisis and the recovery following. Applying a set of algorithms developed at Los Alamos, we are simulating the effect on critical infrastructure components (for example, utilities, transportation, and emergency medical facilities) that were involved following an earthquake in the Los Angeles area. Our ground-motion modeling captured several critical factors; the most important appear to be the nonlinear behavior of soils when subjected to large displacements, basin shape, geologic constituents, and proximity to the fault itself.

As a first step, we simulated the damaging effects on the electric distribution system in the Los Angeles Basin. Coupling a multilayered geographic information system database to the above-described factors, we analyzed the functionality of the damaged electric distribution system. The outcome is a map of the primary blackout areas and the most likely regional and national effects of the blackout. In another coupled simulation, we mapped fragility models onto damaged industrial and commercial building areas, which will allow us to understand the effects on the urban regrowth and evolution.

Urban-regrowth simulations (as described in the project description titled “Urban Change”) could address questions about the urban dynamics on time scales from approximately a month to a few years. Such questions include: Which areas will grow again most rapidly? How sensitive are the regrowth patterns as a function of external economical and demographic factors? Which areas are least compatible with current zoning regulations and which activities would emerge if the zoning laws were changed? Other question of a more long-term nature (such as where the urban area is most likely to expend in the future) can also be addressed with this type of simulation.